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[TITLE OF THE INVENTION] Failure Detecting Device for Multiple-lamp-type Color-lamp signal mechanism Using LED for Light Emission Source

[Abstract] (Corrected)

[Problem(s) to Be Solved] To detect the disconnection failure of an LED used for a light emission source of signal aspect and a failure due to short-circuiting by accurately calculating the failure threshold of the LED, independently of the characteristics of the LED and the installation environment of a signal mechanism.

[Means for Solving the Problem(s)] A plurality of light instruments L1 to L5 are signal lamps for a three-position signal mechanism that use a plurality of LED light emission sources for signals, respectively, and are connected to a signal aspect switching controller 6 with through lines 5a to 5e that pass through each of current sensors 1a to 1c by two or three

lines each. The sensors 1a to 1c detect a consumption current of an aspect signal lamp and are smaller in number than the light instruments. A voltage monitoring device 2 detects an output voltage to a signal mechanism, and a fault detecting part 3 is connected to the sensors 1a to 1c and to the voltage monitoring device 2, synchronously monitors the consumption current of the signal mechanism and the output voltage, calculates a signal mechanism side arrival voltage from synchronously monitored information, calculates a fault threshold in an operation mode, and compares a measured value in the operation mode with the fault threshold in the operation mode to determine faults of the light instruments.

[Scope of Claim for a Patent]

[Claim 1] An LED failure detecting device of a signal lamp in a multiple-lamp-type color-lamp signal mechanism using LEDs for light emission sources, the detecting device characterized by comprising:

a plurality of light instruments;

a current sensor;

a voltage monitoring device; and

a failure detecting part,

wherein the plurality of light instruments are signal lamps of a three-position signal mechanism using a plurality of LEDs as a signal generation source, and are connected to a signal aspect switching controller with a through line that passes through each of the current sensors;

the current sensor detects a consumption current of the signal lamp;

the voltage monitoring device detects an output voltage to a signal mechanism; and

the failure detecting part is connected to the current sensor and to the voltage monitoring device, synchronously monitors a consumption current and an output voltage of the signal mechanism, calculates a signal mechanism side arrival voltage from obtained synchronously monitored information to calculate a failure threshold in the signal mechanism operation

mode, and compares a measured value in the signal mechanism operation mode to make determination of a failure of a light instrument.

[Claim 2] An LED failure detecting device of a signal lamp in a multiple-lamp-type color-lamp signal mechanism using LEDs for light emission sources as claimed in claim 1, characterized in that:

the failure detecting part has a memory part and a processing part;

the memory part stores setting information provided by initial setting, and outputs the setting information to the processing part;

the processing part has a time processing part, a disconnection detecting part, a short circuit detecting part, and an aspect determination part, and calculates a disconnection failure threshold value in the signal mechanism operation mode and a short circuit failure threshold value in the operation mode and outputs their respective failure threshold values to the disconnection detecting part and to the short circuit detecting part, based upon the setting information inputted from the memory part;

the time processing part performs time synchronization processing between a current sensor input and an input from a voltage monitoring device;

the disconnection detecting part makes disconnection determination of an LED from a result of comparison between a measured value in the signal mechanism operation mode and a failure threshold in the signal mechanism operation mode;

the short circuit detecting part makes short circuit determination of an LED from a result of comparison between a measured value in the signal mechanism operation mode and a failure threshold in the signal mechanism operation mode; and

the aspect determination part specifies an aspect from measured-value information obtained via the time processing part and outputs a result of determination between the disconnection detecting part and the short circuit detecting part.

[Claim 3] An LED failure detecting device of a signal lamp in a multiple-lamp-type color-lamp signal mechanism using LEDs for light emission sources as claimed in claim 2, characterized in that:

the disconnection detecting part has a full-disconnection failure determination function and a semi-disconnection determination function, and a normal state determination function,

the full-disconnection determination function is a function of comparing a full-disconnection failure threshold in a signal mechanism operation mode calculated based upon the

setting information stored in the memory part with a measured value in a signal mechanism operation mode, the measured value being calculated from synchronously monitored information, and, when the measured value in the signal mechanism operation mode is lowered more markedly than the full-disconnection threshold value in the signal mechanism operation mode, determining a full-disconnection state in which the LEDs of all of the signal lamps are in a disconnection failure;

the semi-disconnection determination function is a function of comparing a semi-disconnection failure threshold in a signal mechanism operation mode calculated based upon the setting information stored in the memory part with a measured value in a signal mechanism operation mode, the measured value being calculated from synchronously monitored information, and, when the measured value in the signal mechanism operation mode is lowered more markedly than the semi-disconnection threshold value in the signal mechanism operation mode, determining a semi-disconnection state in which the LEDs of part of the signal lamps are in a disconnection failure;

the normal state determination function is a function of, when the measured value in the signal mechanism operation mode, the measured value being calculated from synchronously monitored information, is in the range between the semi-disconnection failure threshold in the signal mechanism

operation mode and the short circuit threshold in the signal mechanism operation mode, determining the LEDs of signal lamps are neither in a state of disconnection nor in a state of short circuit failure;

the short circuit detecting part has a short circuit determination function; and

the short circuit failure determination function is a function of comparing a short circuit threshold in the signal mechanism operation mode, the threshold being calculated based upon the setting information stored in the memory part, with a measured threshold in the signal mechanism operation mode, the measured value being calculated from synchronously monitored information, and, when the measured value in the signal mechanism operation mode is greater than the short circuit threshold in the signal mechanism operation mode, determining a short circuit state in which the LEDs of a number of signal lamps are in a short circuit state.

[Claim 4] An LED failure detecting device of a signal lamp in a multiple-lamp-type color-lamp signal mechanism using LEDs for light emission sources, the detecting device characterized by comprising:

a plurality of light instruments;

a current sensor;

a voltage monitoring device; and

a failure detecting part,

wherein the plurality of light instruments are signal lamps of a three-position signal mechanism using a plurality of LEDs as signal light emission sources, and are connected to a light instrument switching controller with two or three through lines which pass through each of the current sensors;

determination of whether each of the light instruments is lit or not is made according to the presence or absence of a power current to one or two predetermined current sensors;

the current sensor detects a consumption current of a signal lamp and is smaller in number than light instruments;

the voltage monitoring device detects an output voltage to a signal mechanism, and is smaller in number than light instruments; and

the failure detecting part is connected to the current sensor and to the voltage monitoring device, synchronously monitors a consumption current and an output voltage of a signal mechanism, calculates a signal mechanism side arrival voltage from obtained synchronously monitored information to calculate a failure threshold in the signal mechanism operation mode, and compares a measured value in the signal mechanism operation mode to make determination of a failure of a light instrument.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a failure detecting device of color-lamp signal mechanism, in particular, a multiple-lamp-type color-lamp signal mechanism using an LED, which detects a failure of signal aspect caused by disconnection or short-circuiting of an LED in a color lamp signal mechanism using an LED for a signal light emission source, in particular, in a multiple-lamp-type signal mechanism.

[0002]

[Prior Art]

A multiple-lamp-type color-lamp signal mechanism is a signal mechanism which performs signal aspect by using three types of colors (green, yellow, and red), independently or in combination. A three-position color-lamp signal mechanism is of 3-aspect, 4-aspect, or 5-aspect type, and is installed by vertically arranging a combination of individual light instruments.

[0003]

Conventionally, a signal light bulb had been used for a light emission source of a signal mechanism. An LED having its high luminance has been developed and is now employed for a light emission source of a railway signal. Although the LED is never core-broken unlike a light bulb filament, the luminous intensity is gradually lowered if the LED is used for an extended

long time. A time interval for the luminous intensity to be reduced to half is defined as a service life. When it is continuously used outside, it is subjected to a repetitive temperature or humidity change and is subjected to various environmental influences. The service life is considered to be 10,000 hours to 30,000 hours, and a disconnection (open-circuit) accident or a short circuit failure occurs due to degradation or other unexpected circumstance.

[0004]

In respect of a color lamp signal mechanism using an LED for a signal light emission source, in advance of the above-described unexpected circumstances, countermeasures are taken for connecting a dedicated current sensor (CT sensor) to a respective one of signal lamps; monitoring a consumption current value of each lamp by means of a sensor; and, when any of the current values detected for each signal lamp is not greater than a set reference value, determining that an LED of that signal lamp fails; and outputting alerting.

[0005]

When the above-described method is employed, a current sensor is connected to each light instrument, thus necessitating to provide current sensors in number equal to that of light instruments. For example, naturally, five current sensors are required for a 5-aspect multiple-lamp-type

color-lamp signal mechanism.

[0006]

[Problem to Be Solved by the Invention]

Accordingly, the above-described method requires current sensors whose number is equal to that of signal lamps (equal to the number of signal aspects) in a signal mechanism, and this is not preferable in terms of space saving. For this reason, there has been proposed a failure detecting device of LED signal mechanism capable of detecting a failure such as a short circuit or an aspect error as well as detection of an LED disconnection failure using current sensors whose number is smaller than that of signal lamps in the signal mechanism (refer to Japanese Utility Model Application Registration No. 3051830).

[0007]

This device is equipped with: a plurality of arbitrarily arranged current sensors whose number is fewer than that of signal lamps; through lines that pass through these current sensors in arbitrary plurality and provide connection between each of the signal lamps and a signal aspect relay contact circuit, wherein a failure detecting part has a memory part capable of arbitrarily setting a current value according to aspect, compares a set current value of this memory part with a current value measured by each current sensor, and makes determination and display on an abnormal full-disconnection

state, a normal no-disconnection aspect, and an abnormal short circuit aspect.

[0008]

The above device has been developed based upon a concept that a fixed current value preset for a memory part is compared with a current value measured by each current sensor so that a failure determination is made. In failure determination of an LED, however, merely by simply comparing the current value measured by each current sensor with the fixed current value and monitoring its change, it is difficult to determine whether or not the failure occurs owing to the following circumstances. That is,

(1) Light emission sources are a set of semiconductor devices, and a current difference like a core break due to a filament blowout of a light bulb does not occur due to mere disconnections of some LEDs.

(2) In an LED signal, a basic consumption current value is 1/n of that of a light bulb type signal, thus requiring high-precision measurement.

(3) In the LED type signal, a failure current value varies depending upon a power supply and a difference in wiring (cabling) length. If a partial disconnection occurs, a current is reduced. As a result, a terminal voltage rises, and a current value increases, resulting in a small change of the current

value.

(4) A quality of a power supply in a field in which a signal is installed is not always good, and thus, a failure current value cannot be accurately fixed.

(5) A power voltage is often dropped when in use, depending upon an environment of the field in which a signal is installed, and thus, the failure current value may deviate from a set value.

[0009]

Owing to the above-described circumstances, it is difficult to practically detect a failure such as an LED disconnection failure, a short circuit, and an aspect error, merely by monitoring the current value of each sensor.

[0010]

It is an object of the present invention to provide a device for calculating an LED failure threshold, independently of semiconductor device characteristics or a signal installation environment and detecting a failure such as a disconnection failure, a short-circuit, and an aspect error.

[0011]

[Means for Solving the Problem]

In order to achieve the above-described object, an LED failure detecting device of a signal lamp in a multiple-lamp-type color-lamp signal mechanism using an LED for a light emission source is equipped with: a plurality of light

instruments; a current sensor; a voltage monitoring device; and a failure detecting part, wherein the plurality of light instruments are signal lamps of a three-position signal mechanism using a plurality of LEDs for signal generation sources, and are connected to a signal aspect switching controller with a through line that passes through each of the current sensors; the current sensor detects a consumption current of a signal lamp; the voltage monitoring device detects an output voltage to a signal mechanism; and the failure detecting part is connected to the current sensor and the voltage monitoring device, synchronously monitors a consumption current and an output voltage of a signal mechanism, calculates a signal mechanism side arrival voltage from obtained synchronously monitored information to calculate a failure threshold in a signal mechanism operation mode, and compares a measured value in the signal mechanism operation mode to make determination of a failure of a light instrument.

[0012]

The failure detecting part has a memory part and a processing part; the memory part stores setting information set by initial setting, and outputs the setting information to the processing part; and the processing part has a time processing part, a disconnection detecting part, a short-circuiting detecting part, and an aspect determination part. The

processing part calculates a disconnection failure threshold value in the signal mechanism operation mode and a short circuit failure threshold value in the operation mode and outputs their respective failure threshold values to the disconnection detecting part and to the short circuit detecting part, based upon the setting information inputted from the memory part; the time processing part performs time synchronization processing between a current sensor input and an input from a voltage monitoring device; the disconnection detecting part makes determination of disconnection of an LED from a result of comparison between a measured value in the signal mechanism operation mode and a failure threshold in the signal mechanism operation mode; the short circuit detecting part makes determination of short circuiting of an LED from a result of comparison between a measured value in the signal mechanism operation mode and a failure threshold in the signal mechanism operation mode; and an aspect determination part specifies aspect from measured-value information obtained via the time processing part and outputs results of determination of the disconnection detecting part and the short circuit detecting part.

[0013]

The disconnection detecting part has a full-disconnection failure determination function, a

semi-disconnection determination function, and a normal state determination function; the full-disconnection determination function is a function of comparing a full-disconnection failure threshold in a signal mechanism operation mode calculated based upon the setting information stored in the memory part with a measured value in a signal mechanism operation mode, the measured value being calculated from synchronously monitored information, and, when the measured value in the signal mechanism operation mode is lowered more markedly than the full-disconnection threshold value in the signal mechanism operation mode, determining a full-disconnection state in which the LEDs of all of the signal lamps are in a disconnection failure; the semi-disconnection determination function is a function of comparing a semi-disconnection failure threshold in a signal mechanism operation mode calculated based upon the setting information stored in the memory part with a measured value in a signal mechanism operation mode, the measured value being calculated from synchronously monitored information, and, when the measured value in the signal mechanism operation mode is lowered more markedly than the semi-disconnection threshold value in the signal mechanism operation mode, determining a semi-disconnection state in which the LEDs of part of the signal lamps are in a disconnection failure; the normal state

determination function is a function of, when the measured value in the signal mechanism operation mode, the measured value being calculated from synchronously monitored information, is in the range between the semi-disconnection failure threshold in the signal mechanism operation mode and the short circuit threshold in the signal mechanism operation mode, determining the LEDs of signal lamps are neither in a state of disconnection nor in a state of short circuit failure; the short circuit detecting part has a short circuit determination function; and the short circuit failure determination function is a function of comparing a short circuit threshold in the signal mechanism operation mode, the threshold being calculated based upon the setting information stored in the memory part, with a measured threshold in the signal mechanism operation mode, the measured value being calculated from synchronously monitored information, and, when the measured value in the signal mechanism operation mode is greater than the short circuit threshold in the signal mechanism operation mode, determining a short circuit state in which the LEDs of a number of signal lamps are in a short circuit state.

[0014]

An LED failure detecting device of a signal lamp in a multiple-lamp-type color-lamp signal mechanism using LEDs for light emission sources is equipped with: a plurality of light

instruments; a current sensor; a voltage monitoring device; and a failure detecting part, wherein the plurality of light instruments are signal lamps of a three-position signal mechanism using a plurality of LEDs as signal light emission sources, and are connected to a light instrument switching controller with two or three through lines which pass through each of the current sensors; determination of ON/OFF of each of the light instruments is made according to the presence or absence of a power current to one or two predetermined current sensors; the current sensor detects a consumption current of a signal lamp and is smaller than the number of light instruments; the voltage monitoring device detects an output voltage to a signal mechanism, and is fewer than the number of light instruments; the voltage monitoring device detects an output voltage to a signal mechanism; and the failure detecting part is connected to the current sensor and to the voltage monitoring device, synchronously monitors a consumption current and an output voltage of a signal mechanism, calculates a signal mechanism side arrival voltage from obtained synchronously monitored information to calculate a failure threshold in the signal mechanism operation mode, and compares a measured value in the signal mechanism operation mode to make determination of a failure of a light instrument.

[0015]

[Embodiments of the Invention]

Hereinafter, embodiments of the present invention will be described with referring to the accompanying drawings. Fig. 1 is a view showing an arrangement of a device circuit which detects an LED disconnection failure in a 5-aspect LED multiple-lamp-type color-lamp signal mechanism using LEDs for light emission sources. Five light instruments which are five light signal lamps are three-position signal lamps using a plurality of LEDs for signal light emission sources. For example, these light instruments include a combination of a G (Green) light, a Y (Yellow) light; an R (Red) light; an YY (Yellow, Yellow) light; and an YG (Yellow, Green) light. Hereinafter, the light instruments are discriminated as L1, L2, L3, L4, and L5, in this order.

[0016]

In the light instruments L1, L2, L3, L4, and L5, as shown in Fig. 2, a plurality of LEDs of their respective colors are connected in series or in parallel. In Fig. 1, a failure detecting device has: current sensors 1a, 1b, and 1c; a voltage monitoring device 2; and a failure detecting part 3. The signal light instruments L1, L2, L3, L4, and L5 are connected to through lines 5 for current measurement in a signal equipment chamber through a signal cable 4. The through lines 5 for current measurement are passed through current sensors 1a, 1b, and 1c

by two or three lines, and are connected to the light instruments L1, L2, L3, L4, and L5 and to a signal aspect controller 6. The signal aspect switching controller 5 establishes a contact condition required for turning ON/OFF each of the light instruments L1, L2, L3, L4, and L5.

[0017]

The current sensors 1a, 1b, and 1c each detect a consumption current of a signal mechanism. In this embodiment, three current sensors are used for five signal lamps. In Fig. 3, in this embodiment, through lines 5b, 5c, and 5d for current measurement connected to light instruments L2, L3, and L4 are passed through the current sensor 1b. These through lines 5a and 5b for current measurement connected to the light instrument L1 and to the light instrument L2 drawn out from the current sensor 1b are passed through the current sensor 1a. Further, through lines 5d and 4e for current measurement connected to the light instrument L5 and the light instrument L4 drawn out from the current sensor 1b are passed through the current sensor 1c and both of these lines are connected to the signal aspect switching controller 6.

[0018]

In Fig. 3, when the light instrument L1 is lit, the current sensor 1a is turned "ON". When the light instrument L2 is lit, the current sensors 1a and 1b are turned "ON". When the light

instrument L3 is lit, the current sensor 1b is turned "ON". When the light instrument L3 is lit, the current sensor 1b is turned "ON". When the light instrument L4 is lit, the current sensor CT1 is turned "ON". When the light instrument L4 is lit, the current sensors 1b and 1c are turned "ON". When the light instrument L3 is lit, the current sensor 1b is turned "ON". The detected output obtained at each of the current sensors is inputted to a failure detecting part 3. The above result is shown in Table 1.

[0019]

[Table 1]

Whether or not a current of each current sensor is present.			Result of determination of whether each of the lights is lit or not
A	B	C	
○	×	×	L1 is lit.
×	○	×	L3 is lit.
×	×	○	L5 is lit.
○	○	×	L2 is lit.
×	○	○	L4 is lit.
×	×	×	All of L1 to L5 go out.

o: Present

x: Absent

[0020]

A voltage monitoring device 2 detects an output voltage to a signal mechanism. This monitoring device is connected in parallel to an output side wire of a signal lamp transformer 7 of a signal cable together with a signal aspect switching controller 6. All of the detected outputs are inputted to a failure detecting part 3. The failure detecting part 3 is a CPU, and has a memory part 8 and a processing part 9, as shown in Fig. 4. An analog signal between each of the current sensors 1a, 1b, and 1c and the voltage monitoring device 2 is inputted to an input part 3a of the detecting part, and a digital signal converted at the input part 3a is signal-processed at the processing part 9.

[0021]

The memory part 8 stores setting information provided by initial setting, and outputs the setting information to the processing part 9. The processing part 9 consists of a time processing part, a disconnection detecting part 11, a short circuit detecting part 12, and an aspect determination part 13. Based upon the setting information inputted from the memory part 8, a disconnection failure threshold in the signal mechanism operation mode and a short circuit failure threshold in an operation mode are calculated, and then, their respective failure thresholds are outputted to the disconnection failure

detecting part 11 and the short circuit detecting part 12. The time processing part 10 performs time synchronization processing between an input from each of the current sensors 1a, 1b, and 1c and an input from the voltage monitoring device 2, and outputs the synchronously monitored information to the disconnection detecting part 11 and the short circuit part 12.

[0022]

The disconnection detecting part 11 synchronously monitors a consumption current of a signal, the consumption current being outputted from each of the current sensors 1a, 1b, and 1c, and an output voltage outputted from the voltage monitoring device 2. The synchronously monitored information is computer-processed; a signal mechanism side arrival voltage (an arrival voltage) is calculated, and a disconnection failure current value (a disconnection failure threshold) is calculated, making the determinations of a full-disconnection failure, a semi-disconnection failure, and normal state of an LED of a signal lamp.

[0023]

The full-disconnection failure determination function, the semi-disconnection failure determination function, and the normal state determination function performed by the disconnection detecting part 11 are described as follows. That is, the full-disconnection failure determination function is

a function of comparing a full-disconnection failure threshold in a signal mechanism operation mode calculated based upon the setting information stored in the memory part with a measured value in a signal mechanism operation mode, the measured value being calculated from synchronously monitored information, and, when the measured value in the signal mechanism operation mode is lowered more markedly than the full-disconnection threshold value in the signal mechanism operation mode, determining a full-disconnection state in which the LEDs of all of the signal lamps are in a disconnection failure;

[0024]

The semi-disconnection failure determination function is a function of, comparing a semi-disconnection failure threshold in a signal mechanism operation mode calculated based upon the setting information stored in the memory part with a measured value in a signal mechanism operation mode, the measured value being calculated from synchronously monitored information, and, when the measured value in the signal mechanism operation mode is lowered more markedly than the semi-disconnection threshold value in the signal mechanism operation mode, determining a semi-disconnection state in which the LEDs of part of the signal lamps are in a disconnection failure;

[0025]

The normal state display function is a function of, when

the measured value in the signal mechanism operation mode, the measured value being calculated from synchronously monitored information, is in the range between the semi-disconnection failure threshold in the signal mechanism operation mode and the short circuit threshold in the signal mechanism operation mode, determining that any of the LEDs of signal lamps are normal in aspect without disconnection, without disconnection free of a short circuit failure, or without a short circuit.

[0026]

A short circuit detecting part 12 synchronously monitors a consumption current of a signal mechanism, the consumption current being outputted from the current sensors 1a, 1b, and 1c, and also monitors an output voltage outputted from the voltage monitoring device 2. The synchronously monitored information is computer-processed; a signal mechanism side arrival voltage (an arrival voltage) is calculated; and a short circuit failure current value (a failure threshold) is calculated, making determination of whether or not an LED is short circuited.

[0027]

The short circuit failure determination function performed by the short circuit detecting part 12 is a function of comparing a short circuit threshold in the signal mechanism operation mode, the threshold being calculated based upon the

setting information stored in the memory part 8, with a measured threshold in the signal mechanism operation mode, the measured value being calculated from synchronously monitored information, and, when the measured value in the signal mechanism operation mode is greater than the short circuit threshold in the signal mechanism operation mode, determining a short circuit state in which the LEDs of many signal lamps are in a short circuit state.

[0028]

A result of measurement between the disconnection detecting part 11 and the short circuit detecting part 12 is outputted to the aspect determination part 13. The aspect determination part 13 specifies aspect from the measured value information obtained via the time processing part and displays a result of determination between the disconnection detecting part 11 and the short circuit detecting part 12. Further, when necessary, this determination part outputs alerting.

[0029]

Fig. 5 shows a flow of failure detection processing executed by the failure detecting part 3. In Fig. 5, the current measurement inputs obtained at the current sensors 1a, 1b, and 1c and the voltage measurement inputs obtained at the voltage monitoring device 2 are provided to an input part, respectively (step 1). Next, both of these inputs are subjected to time

synchronization processing at the time processing part 10 of the processing part 9 (step 2). Then, at the processing part 9, the signal consumption power outputted from the current sensors 1a, 1b, and 1c and the output voltage outputted from the voltage monitoring device 2 are synchronously monitored, and synchronously monitored information is obtained (step 3).

[0030]

Aspect determination processing is performed based upon this synchronously monitored information (step 4). When this aspect determination processing is performed, initial setting information is inputted to the memory part 8, and then, a signal mechanism side arrival voltage (an arrival voltage) is calculated from the synchronously monitored information (step 5). Then, the disconnection failure current value (a failure threshold) and the short circuit failure current value (a failure threshold) are calculated (step 6). Then, the full-disconnection threshold, the semi-disconnection threshold, or the short circuit threshold in the signal mechanism operation mode calculated based on the initial setting information stored in the memory section 8 is compared with the measured value in the signal mechanism operation mode calculated from the synchronously monitored information, and failure determination of full-disconnection, semi-disconnection, or short circuit is performed (step 7).

When a failure continuation time exceeds a predetermined time, alerting is outputted (step 8), and the display part 14 displays the contents of the failure that has occurred.

[0031]

When a failure is not determined in step 7 or even if a failure has occurred, a normal state is displayed when the failure continuation time does not exceed a predetermined time (step 9). Fig. 6 shows an exemplary relationship between a voltage and a current in each failure region, as a criteria for determinations of a full-disconnection failure, a semi-disconnection failure, and a short circuit failure in step 8.

[0032]

In Fig. 6, (an output voltage - an arrival voltage) is plotted along the horizontal axis and (an operating current/a full light-up current) x 100 is plotted along the vertical axis. When the horizontal-axis scale is 0, i.e., when the arrival voltage is equal to the output voltage, a ratio of an operating current to full-light-up current is set to 125% as the lower limit. If this rate is exceeded, it is defined as a short circuit failure region. When the upper limit is 50%, if the rate is below the upper limit, it is defined as a full-disconnection region. When the lower and upper limits are 50% and 75%, respectively, a range from 50% to 75% is set in

the semi-disconnection failure region. As a result, a range between 75% and 125% is defined as a normal operation region. As the arrival voltage increases, the upper limit value of the semi-disconnection failure and that of the full-disconnection failure rise.

[0033]

In the present invention, it is determined whether 5 signal light instruments are lit or not by detecting the presence or absence of the current(s) flowing through one or two of the three current sensors. Further, it is determined whether signal aspect is normal or abnormal by synchronously monitoring the signal consumption current outputted from each of the current sensors and the output voltage outputted from the voltage monitoring device to the signal. When a full-disconnection failure, a semi-disconnection failure, or a short circuit failure occurs with an LED used for each of the signal light instruments, alerting is outputted as well as the contents of the failure that has occurred are displayed altogether.

[0034]

The multiple-lamp-type color-lamp signal mechanism to which the present invention is applied is not limited to an exemplary 5-aspect signal lamp. In a 4-aspect or less signal mechanism also, a minimum of three current sensors are required

for detecting disconnection. Thus, in the present invention, in particular, it is suitable to use this multiple-lamp-type color-lamp signal mechanism for a 5-aspect signal mechanism. The failure detecting device of the present invention is not limited to a case in which the device is adapted for a failure detecting device using current sensors whose number is fewer than that of signal aspects. This device is completely similarly applicable to a general failure detecting device using current sensors for failure detection of an LED of the multiple-lamp-type color-lamp signal mechanism.

[0035]

[Advantageous Result of the Invention]

As described above, according to the present invention, it is possible to synchronously monitor the consumption current of an LED used for a light emission source of a multiple-lamp-type color-lamp signal mechanism and an output voltage to a signal lamp; to calculate a signal mechanism side arrival voltage (an arrival voltage) from the synchronously monitored information; to calculate full-disconnection, semi-disconnection, and short circuit failure current values (failure threshold values); and to compare the measurement result in a signal mechanism operation mode with the failure threshold to determine the full-disconnection failure, the semi-disconnection failure, and the short circuit failure.

Thus, even if there is no current drop such as that in light bulb filament blowout as well as the full-disconnection failure and short circuit failure, the failure threshold is set, thereby making it possible to accurately monitor a partial disconnection which exceeds the threshold setting.

[0036]

According to the present invention, it is possible to appropriately determine an LED light-up failure regardless of conditions for a signal installation field such as: power supply; whether the length of wiring cable between signals is long or short; power supply quality; and a power voltage drop. Further, according to the present invention, it is possible to determine a degree of an LED disconnection by more accurately measuring the light-up current of a specified light instrument.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a structural view of a failure detection circuit showing one embodiment of the present invention.

[Fig. 2]

Fig. 2 is a circuit diagram of an LED of a signal lamp.

[Fig. 3]

Fig. 3 is a schematic view of a circuit for detecting whether each light instrument is lit or not.

[Fig. 4]

Fig. 4 is a structural view of a failure detecting part.

[Fig. 5]

Fig. 5 is a flowchart of failure detection processing.

[Fig. 6]

Fig. 6 is a view showing a determination region of a disconnection failure and a short circuit failure.

[Reference Numerals]

1a to 1c: Current sensors

2: Voltage monitoring device

3: Failure detecting part

4: Signal cable

5 (5a to 5e): Through lines for current measurement

6: Controller

6: Signal aspect switching controller

7: Signal lamp transformer

8: Memory part

9: Processing part

10: Time processing part

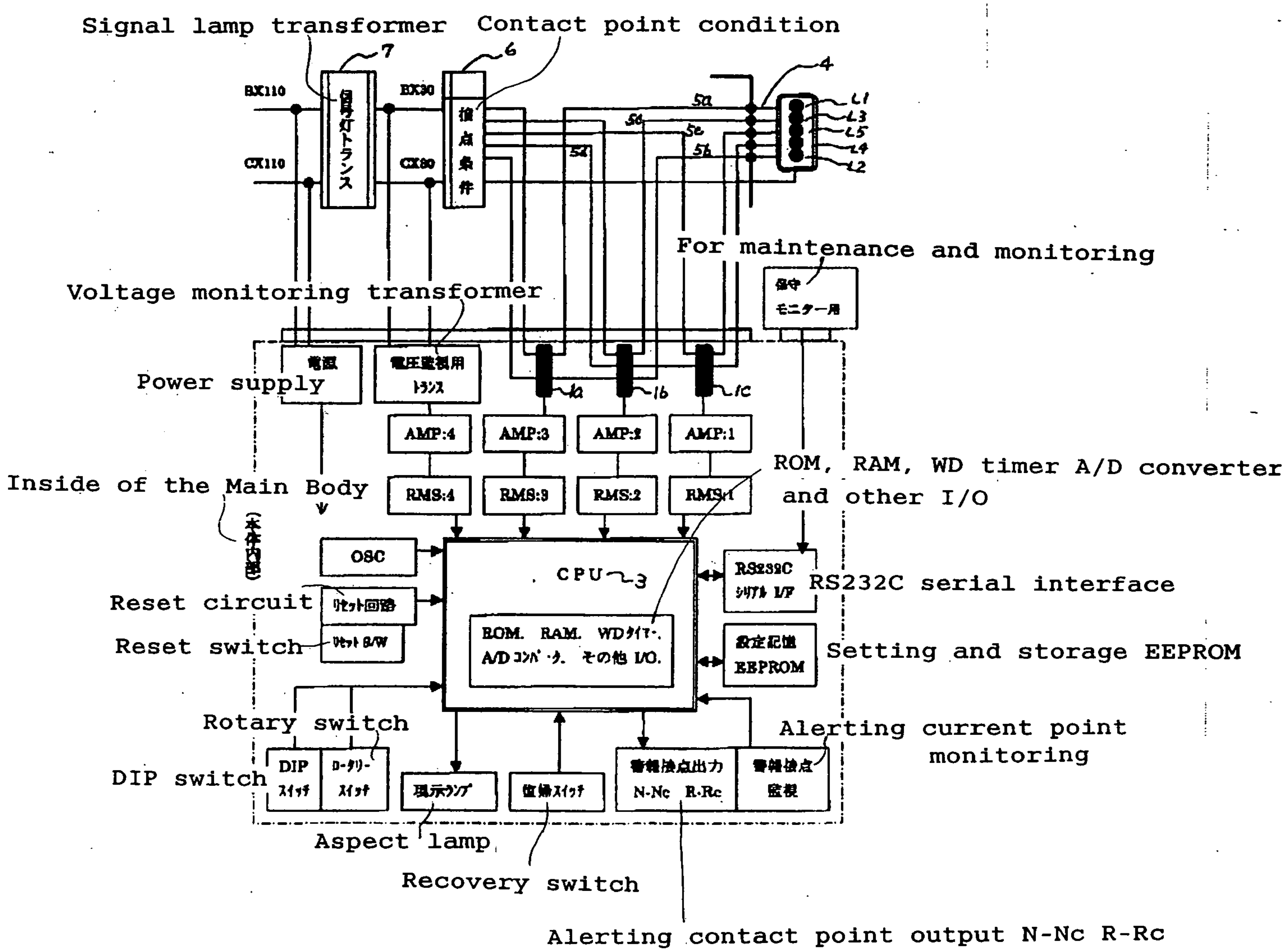
11: Disconnection detecting part

12: Short circuit detecting part

13: Aspect determination part

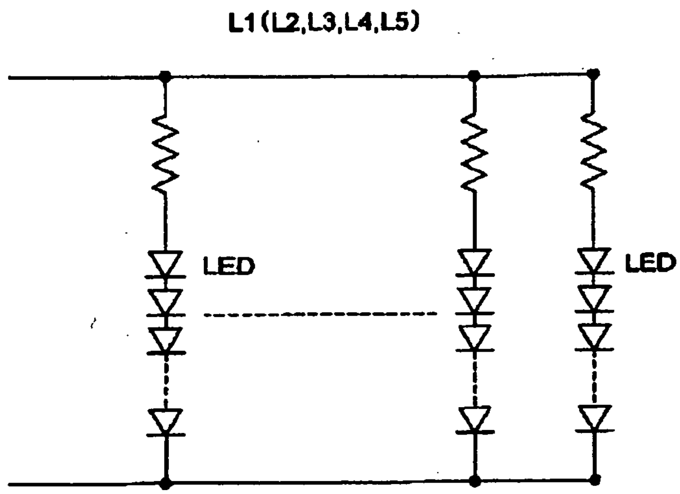
14: Display part

[Fig. 1]

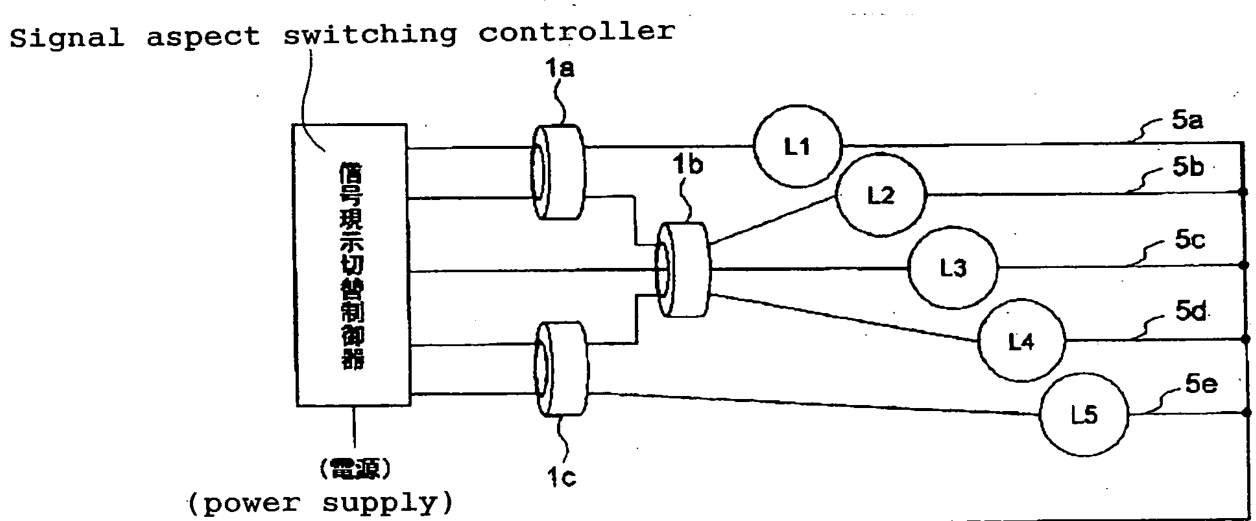


Internal Configuration of Failure Detecting Device for LED Signal Mechanism

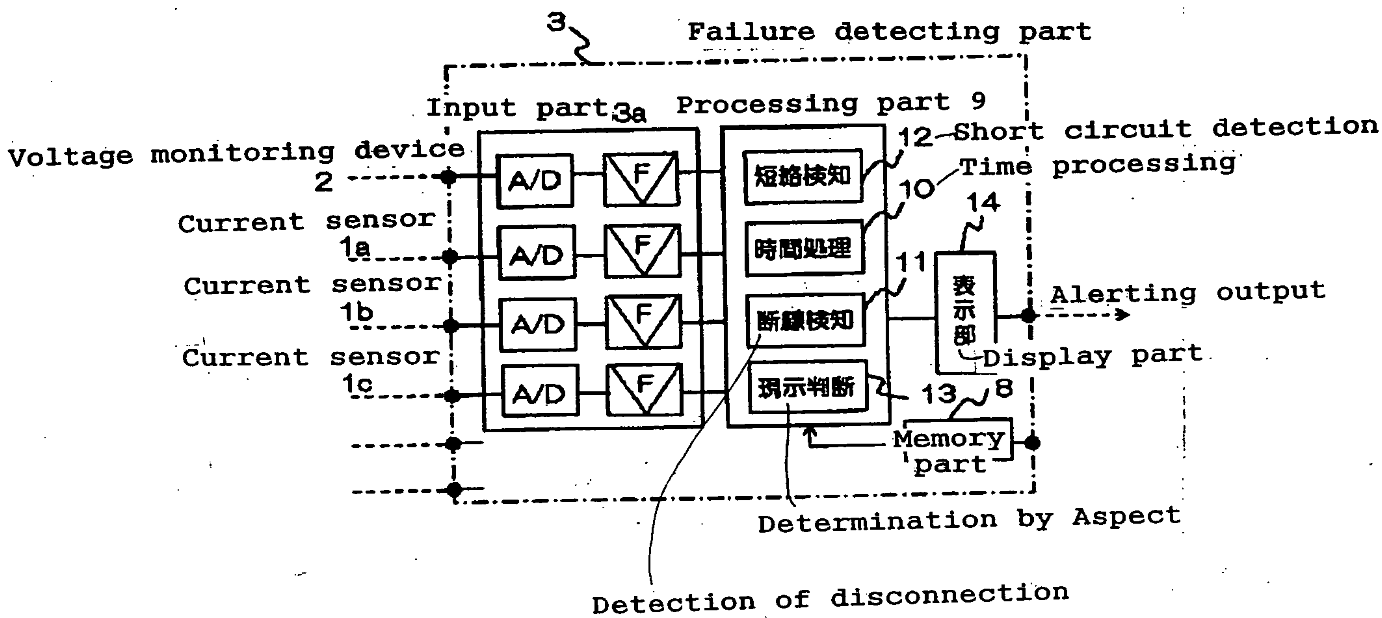
[Fig. 2]


L1(L2,L3,L4,L5)
LED
LED

[Fig. 3]

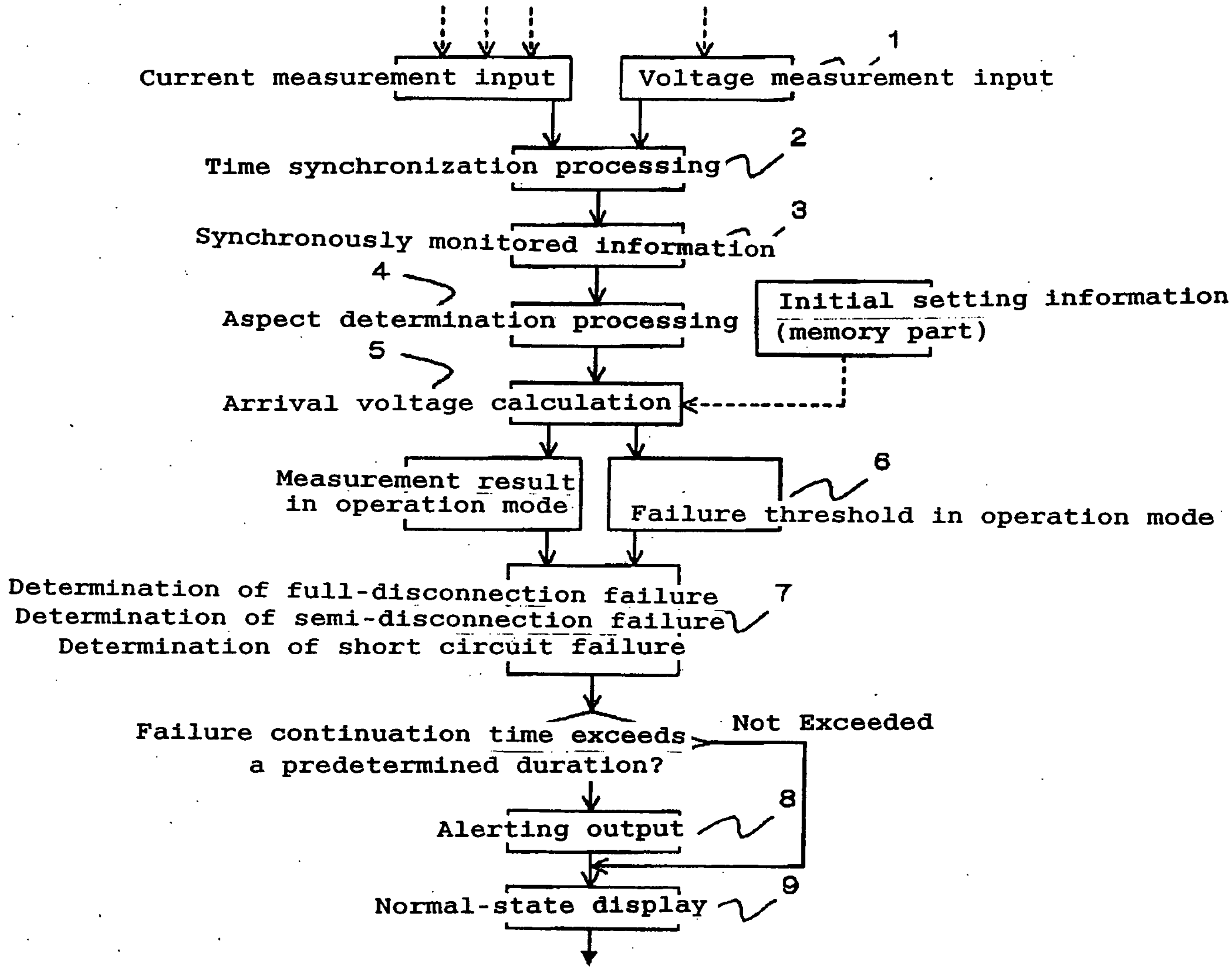

Signal aspect switching controller
1a
1b
1c
信号現示切替制御器
L1
L2
L3
L4
L5
5a
5b
5c
5d
5e
(電源)
(power supply)

[Fig. 4]



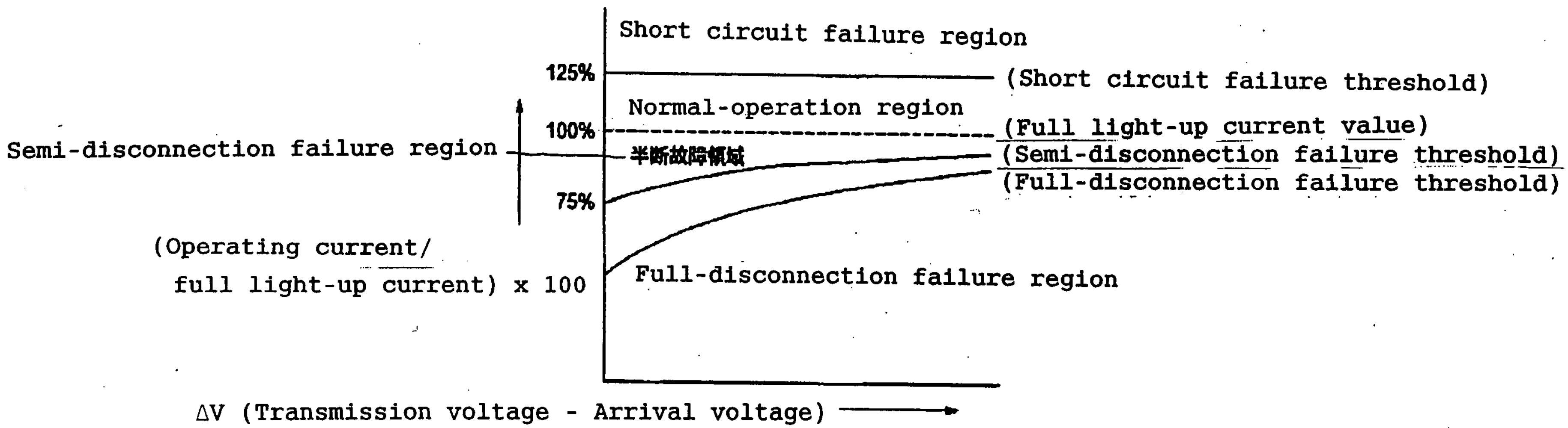
3
Failure detecting part
Input part
3a
Processing part 9
12
Short circuit detection
10
Time processing
Voltage monitoring device
2
A/D
F
短絡検知
時間処理
断線検知
現示判断
Current sensor
1a
Current sensor
1b
Current sensor
1c
14
11
表示部
Alerting output
Display part
13
8
Memory part
Determination by Aspect
Detection of disconnection

[Fig. 5]



Current measurement input
Voltage measurement input
1
Time synchronization processing
2
Synchronously monitored information
3
4
Aspect determination processing
Initial setting information
(memory part)
5
Arrival voltage calculation
Measurement result
in operation mode
Failure threshold in operation mode
6
Determination of full-disconnection failure
Determination of semi-disconnection failure
Determination of short circuit failure
7
Failure continuation time exceeds
a predetermined duration?
Not Exceeded
Alerting output
8
Normal-state display
9

[Fig. 6]



Relationship between each failure region and voltage current

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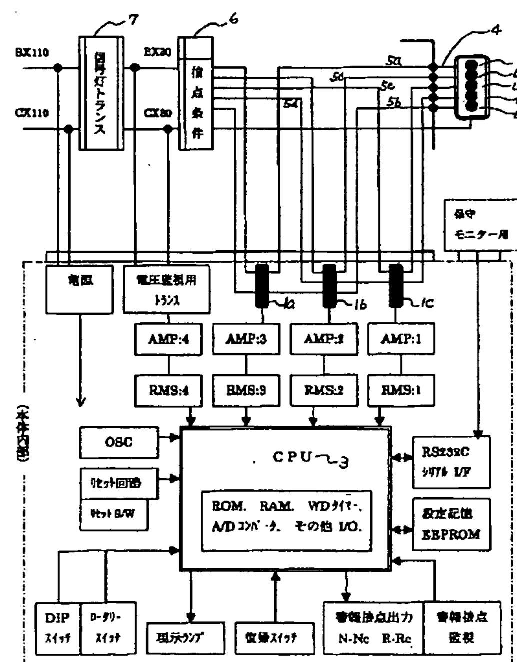
(54)【発明の名称】　ＬＥＤを発光源に用いた多灯形色灯信号機の故障検知装置

(57)【要約】　　（修正有）
【課題】　ＬＥＤの特性や、信号機の設置環境に左右されずにＬＥＤの故障限界値を正確に割り出して、信号現示の発光源に用いられたＬＥＤ断線故障、短絡による故障を検知する。
【解決手段】　複数の灯器Ｌ１〜Ｌ５は、各々複数個のＬＥＤを信号の発光源とする三位式の信号機の信号灯で、各電流センサ１ａ〜１ｃに２本又は３本ずつ貫通させた貫通線５ａ〜５ｅをもって信号現示切替え制御器６に接続される。電流センサ１ａ〜１ｃは、現示信号灯の消費電流を検知し、灯器の数よりも少ない。電圧監視装置２は、信号機への送出端電圧を検知し、故障検知部３は、電流センサ１ａ〜１ｃと電圧監視装置２とに接続され、信号機の消費電流と送出端電圧とを同期監視し、同期監視情報から信号機側到達電圧を計算して稼動時の故障限界値を割り出し、稼動時の測定値を稼動時の故障限界値と比較して灯器の故障の判定を行う。



ＬＥＤ信号機用断線検知器 内部構成図

【特許請求の範囲】

【請求項１】　複数の灯器と、電流センサと、電圧監視装置と、故障検知部とを有するＬＥＤ式多灯形色灯信号機における信号灯のＬＥＤ故障検知装置であって、
複数の灯器は、複数個のＬＥＤを信号の発源とする三位式信号機の信号灯であり、各電流センサに貫通させた貫通線をもって信号現示切替え制御器に接続され、
電流センサは、信号灯の消費電流を検知するものであり、
電圧監視装置は、信号機への送出端電圧を検知するものであり、
故障検知部は、電流センサと電圧監視装置とに接続され、信号機の消費電流と送出端電圧とを同期監視し、得られた同期監視情報から信号機側到達電圧を計算して信号機稼動時の故障限界値を割り出し、信号機稼動時の測定値を信号機稼動時の故障限界値と比較して灯器の故障の判定を行うものであることを特徴とするＬＥＤを発光源に用いた多灯形色灯信号機の故障検知装置。

【請求項２】　故障検知部はメモリ部と処理部とを有し、
メモリ部は、初期設定により設定された設定情報を記憶し、その設定情報を処理部に出力するものであり、
処理部は、時間処理部と、断線検知部と、短絡検知部と、現示判断部とを有し、メモリ部から入力された設定情報をもとに、信号機稼動時の断線故障限界値と、稼動部時の短絡故障限界値とを割り出してそれぞれの故障限界値を断線検知部と短絡検知部とに出力するものであり、
時間処理部は、電流センサ入力と、電圧監視装置からの入力との時間同期処理を行うものであり、
断線検知部は、信号機稼動時の測定値と信号機稼動時の故障限界値との比較結果からＬＥＤの断線判定を行うものであり、
短絡検知部は、信号機稼動時の測定値と信号機稼動時の故障限界値との比較結果からＬＥＤの短絡判定を行うものであり、
現示判断部は、時間処理部を経由して得られた測定値情報から、現示の特定を行うとともに、断線検知部と、短絡検知部との判定結果を出力するものであることを特徴とする請求項１に記載のＬＥＤを発光源に用いた多灯形色灯信号機の故障検知装置。

【請求項３】　断線検知部は、全断異常判定機能と、半断異常判定機能と、正常判定機能とを有し、
全断異常判定機能は、メモリ部に記憶されている設定情報をもとに計算した信号機稼動状態における全断故障限界値と、同期監視情報から演算された信号機稼動状態における測定値とを比較し、信号機稼動状態における全断故障限界値よりも信号機稼動状態における測定値が低下しているときは全ての信号灯のＬＥＤが断線故障している全断状態であると判断する機能であり、
半断異常判定機能は、メモリ部に記憶されている設定情報をもとに計算した信号機稼動状態における半断故障限界値と、同期監視情報から演算された信号機稼動状態における測定値とを比較し、信号機稼動状態における半断故障限界値よりも信号機稼動状態における測定値が低下しているときは信号灯の一部のＬＥＤが断線故障している半断状態であると判断する機能であり、
正常判定機能は、同期監視情報から演算された信号機稼動状態における測定値が、信号機稼動状態における半断故障限界値と、信号機稼動状態における短絡故障限界値との範囲内のときにはいずれの信号灯のＬＥＤも断線又は短絡故障していない状態であると判断する機能であり、
短絡検知部は、短絡異常判定機能を有し、
短絡異常判定機能は、メモリ部に記憶されている設定情報をもとに計算した信号機稼動状態における短絡故障限界値と、同期監視情報から演算された信号機稼動状態における測定値とを比較し、信号機稼動状態における短絡故障限界値よりも信号機稼動状態における測定値が上回っているときには、多数の信号灯のＬＥＤが短絡している短絡状態であると判断する機能であることを特徴とする請求項２に記載のＬＥＤを発光源に用いた多灯形色灯信号機の故障検知装置。

【請求項４】　複数の灯器と、電流センサと、電圧監視装置と、故障検知部とを有するＬＥＤ式多灯形色灯信号機における信号灯のＬＥＤ故障検知装置であって、
複数の灯器は、複数個のＬＥＤを信号の発光源とする三位式信号機の信号灯であり、各電流センサに２本又は３本ずつ貫通させた貫通線をもって灯器切替え制御器に接続され、
各灯器の点灯、消灯の判断は、予め定められた一つまたは二つの電流センサへの通電電流の有無によって行われるものであり、
電流センサは、信号灯の消費電流を検知するものであり、灯器の数よりも少なく、
電圧監視装置は、信号機への送出端電圧を検知するものであり、
故障検知部は、電流センサと電圧監視装置とに接続され、信号機の消費電流と送出端電圧とを同期監視し、その同期監視情報から信号機側到達電圧を計算して信号機稼動時の故障限界値を割り出し、信号機稼動時の測定値を信号機稼動時の故障限界値と比較して灯器の故障の判定を行うものであることを特徴とするＬＥＤを発光源に用いた多灯形色灯信号機の故障検知装置。

【発明の詳細な説明】

【０００１】
【発明の属する技術分野】本発明は、信号の発光源にＬＥＤを用いた色灯信号機、特に多灯形色灯信号機におけるＬＥＤの断線、短絡に基因した信号現示の故障を検知するＬＥＤを発光源に用いた多灯形色灯信号機の故障検

知装置に関する。

【０００２】

【従来の技術】多灯形色灯信号機は、３種類の灯色（緑、黄、赤）を単独に又は併用して信号現示を行う信号機であり、三位式色灯信号機には３現示、４現示、５現示のものがあり、何れも単一の灯器を組合わせを垂直にならべて設置される。

【０００３】従来、信号機の発光源には、信号電球が使用されてきたが、高輝度のＬＥＤが開発されるようになって、鉄道信号の発光源にもＬＥＤが用いられるようになってきた。ＬＥＤは、電球のフィラメントのように断芯することはないが、長時間使用すると、次第に光度が低下するという問題があり、光度が半減するまでの時間を寿命と定められており、屋外で連続使用する場合には温度、湿度の繰返し変化を受けるほか種々の環境の影響を受けることもあって、寿命は一般に１万～３万時間と考えられているが、劣化その他不測の事態によって断線（オープン）事故、短絡故障が発生する。

【０００４】信号の発光源にＬＥＤを用いた色灯信号機には、上記のような不測の事態に備え、それぞれの信号灯に専用の電流センサ（ＣＴセンサ）を接続し、各灯の消費電流値をセンサで監視し、各信号灯ごとに検知する電流値の何れかが設定基準値以下のときには、その信号灯のＬＥＤが故障であると判断し、警報を出力するという対策が講じられている。

【０００５】上記の方法によるときには、各灯器毎に電流センサを接続するため、灯器と同数の電流センサが必要になる。例えば、５現示の多灯形色灯信号機には、当然５個の電流センサが必要である。

【０００６】

【発明が解決しようとする課題】したがって、上記方法では、信号機内の信号灯の数（信号現示数と同じ）と同じ数量の電流センサが必要であり、スペース的にも好ましくないという理由から、信号機内の信号灯の数より少ない電流センサを用いてＬＥＤの断線故障の検知のみならず、短絡、現示異常などの故障をも検知することができるＬＥＤ式信号機の故障検知装置が提案された（実用新案登録第３０５１８３０号公報参照）。

【０００７】この装置は、要するに、信号灯のの数より少ない任意の複数配設された電流センサと、これら電流センサの中をそれぞれ任意の複数ずつ貫通して信号灯と信号現示用リレー接点回路をそれぞれ接続する電流測定用の貫通線と、電流センサに接続された故障検知部とを具え、故障検知部は、現示に応じて任意に電流値を設定可能なメモリ部を有し、このメモリ部の設定電流値と、各電流センサで測定される電流値とを比較して全断状態の現示異常、断線なしの現示正常、短絡状態の現示異常の判断並びにその表示を行うというものである。

【０００８】ところが、上記装置は、メモリ部に予め設定された固定電流値と、各電流センサで測定される電流値とを比較して故障判定を行うという構想の下に開発された装置であるが、ＬＥＤの故障判定に、各電流センサで測定される電流値を単純に固定電流値と比較し、その変化を監視するのみでは、以下のような事情が原因になって、その正否を判定することは難しい。すなわち、

（１）発光源が半導体素子の集合体であり、いくつかのＬＥＤが断線したのみでは、電球のフィラメントの溶断による断芯のような電流落差が生じない。

（２）ＬＥＤ式信号機では、基本消費電流値が、電球式に比べて数分の一程度であるため、高精度の測定が必要とされる、

（３）ＬＥＤ式では、電源と、信号機の配線（ケーブル）の長さの違いによって故障電流値が変化する。部分断線が発生すると、電流が減少し、その結果、端子電圧が上昇し、電流値を増大するため、結果として、電流値の変化が小さい。

（４）信号機設置現場の電源の品質が必ずしも良くないため、故障電流値を正確に固定できないことがある、

（５）信号機設置現場の環境によっては、電源電圧を落として使用されることが多く、このため故障電流値が設定値からずれることがある、といった事情である。

【０００９】このような事情が原因となって、各センサーの電流値を監視するだけでは、実用上、ＬＥＤの断線故障、短絡、現示異常などの故障を検知することは難しい。

【００１０】本発明の目的は、半導体素子の特性や、信号機の設置環境に左右されずにＬＥＤの故障限界値を正確に割り出して、断線故障、短絡、現示異常などの故障を検知する装置を提供することにある。

【００１１】

【課題を解決するための手段】上記目的を達成するため、本発明によるＬＥＤを発光源に用いた多灯形色灯信号機の故障検知装置においては、複数の灯器と、電流センサと、電圧監視装置と、故障検知部とを有するＬＥＤ式多灯形色灯信号機における信号灯のＬＥＤ故障検知装置であって、複数の灯器は、複数個のＬＥＤを信号の発源とする三位式の信号機の信号灯であり、各電流センサに貫通させた貫通線をもって信号現示切替え制御器に接続され、電流センサは、信号灯の消費電流を検知するものであり、電圧監視装置は、信号機への送出端電圧を検知するものであり、故障検知部は、電流センサと電圧監視装置とに接続され、信号機の消費電流と送出端電圧とを同期監視し、得られた同期監視情報から信号機側到達電圧を計算して信号機稼動時の故障限界値を割り出し、信号機稼動時の測定値を信号機稼動時の故障限界値と比較して灯器の故障の判定を行うものである

【００１２】また、故障検知部はメモリ部と処理部とを有し、メモリ部は、初期設定により設定された設定情報を記憶し、その設定情報を処理部に出力するものであり、処理部は、時間処理部と、断線検知部と、短絡検知

部と、現示判断部とを有し、メモリ部から入力された設定情報をもとに、信号機稼動時の断線故障限界値と、稼動部時の短絡故障限界値とを割り出してそれぞれの故障限界値を断線検知部と短絡検知部とに出力するものであり、時間処理部は、電流センサ入力と、電圧監視装置からの入力との時間同期処理を行うものであり、断線検知部は、信号機稼動時の測定値と信号機稼動時の故障限界値との比較結果からＬＥＤの断線判定を行うものであり、短絡検知部は、信号機稼動時の測定値と信号機稼動時の故障限界値との比較結果からＬＥＤの短絡判定を行うものであり、現示判断部は、時間処理部を経由して得られた測定値情報から現示の特定を行うとともに、断線検知部と、短絡検知部との判定結果を出力するものである。

【００１３】また、断線検知部は、全断異常判定機能と、半断異常判定機能と、正常判定機能とを有し、全断異常判定機能は、メモリ部に記憶されている設定情報をもとに計算した信号機稼動状態における全断故障限界値と、同期監視情報から演算された信号機稼動状態における測定値とを比較し、信号機稼動状態における全断故障限界値よりも信号機稼動状態における測定値が低下しているときは全ての信号灯のＬＥＤが断線故障している全断状態であると判断する機能であり、半断異常判定機能は、メモリ部に記憶されている設定情報をもとに計算した信号機稼動状態における半断故障限界値と、同期監視情報から演算された信号機稼動状態における測定値とを比較し、信号機稼動状態における半断故障限界値よりも信号機稼動状態における測定値が低下しているときは信号灯の一部のＬＥＤが断線故障している半断状態であると判断する機能であり、正常判定機能は、同期監視情報から演算された信号機稼動状態における測定値が、信号機稼動状態における半断故障限界値と、信号機稼動状態における短絡故障限界値との範囲内のときにはいずれの信号灯のＬＥＤも断線又は短絡故障していない状態であると判断する機能であり、短絡検知部は、短絡異常判定機能を有し、短絡異常判定機能は、メモリ部に記憶されている設定情報をもとに計算した信号機稼動状態における短絡故障限界値と、同期監視情報から演算された信号機稼動状態における測定値とを比較し、信号機稼動状態における短絡故障限界値よりも信号機稼動状態における測定値が上回っているときには多数の信号灯のＬＥＤが短絡している短絡状態であると判断する機能である。

【００１４】また、複数の灯器と、電流センサと、電圧監視装置と、故障検知部とを有するＬＥＤ式多灯形色灯信号機における信号灯のＬＥＤ故障検知装置であって、複数の灯器は、複数個のＬＥＤを信号の発光源とする三位式信号機の信号灯であり、各電流センサに２本又は３本ずつ貫通させた貫通線をもって灯器切替え制御器に接続され、各灯器の点灯、消灯の判断は、予め定められた一つまたは二つの電流センサへの通電電流の有無によって行われるものであり、電流センサは、信号灯の消費電流を検知するものであり、灯器の数よりも少なく、電圧監視装置は、信号機への送出端電圧を検知するものであり、故障検知部は、電流センサと電圧監視装置とに接続され、信号機の消費電流と送出端電圧とを同期監視し、その同期監視情報から信号機側到達電圧を計算して信号機稼動時の故障限界値を割り出し、信号機稼動時の測定値を信号機稼動時の故障限界値と比較して灯器の故障の判定を行うものである。

【００１５】

【発明の実施の形態】以下に本発明の実施の形態を図によって説明する。図１は、発光源にＬＥＤを用いた５現示のＬＥＤ式多灯形色灯信号機におけるＬＥＤ断線故障を検知する装置回路の構成を示す図である。５灯の信号灯である５灯の灯器は、複数個のＬＥＤを信号の発光源とする三位式の信号機の信号灯であり、例えばＧ（緑）灯、Ｙ（黄）灯、Ｒ（赤）灯、ＹＹ(黄、黄)灯、ＹＧ(黄、黄)灯の組み合わせであって、以下これを順にＬ１、Ｌ２、Ｌ３、Ｌ４、Ｌ５として区別する。

【００１６】各灯器Ｌ１、Ｌ２、Ｌ３、Ｌ４、Ｌ５は、図２に示すようにそれぞれの発色の複数のＬＥＤを直並列に接続したものである。図１において、故障検知装置は、電流センサ１ａ，１ｂ，１ｃと、電圧監視装置２と、故障検知部３とを有している。信号灯の灯器Ｌ１、Ｌ２、Ｌ３、Ｌ４、Ｌ５は、信号ケーブル４を通じて信号機器室内の電流測定用貫通線５に接続されている。電流測定用貫通線５は、各電流センサ１ａ，１ｂ，１ｃに２本又は３本ずつ貫通して各灯器Ｌ１、Ｌ２、Ｌ３、Ｌ４、Ｌ５と信号現示切替え制御器６にそれぞれ接続するものである。信号現示切替え制御器６は、各灯器Ｌ１、Ｌ２、Ｌ３、Ｌ４、Ｌ５の点灯、消灯に必要な接点条件を形成するものである。

【００１７】電流センサ１ａ，１ｂ，１ｃは、信号機の消費電流を検知するものであり、この実施形態においては、５個の信号灯に対して３個の電流センサを用いている。図３において、この実施形態においては、電流センサ１ｂには灯器Ｌ２、Ｌ３、Ｌ４にそれぞれつながる３本の電流測定用貫通線５ｂ，５ｃ，５ｄが挿通され、電流センサ１ａには、灯器Ｌ１と、電流センサ１ｂから引き出された灯器Ｌ２とにつながる電流測定用貫通線５ａ、５ｂが挿通され、さらに、電流センサ１ｃには、灯器Ｌ５と、電流センサ１ｂから引き出された灯器Ｌ４とにつながる電流測定用貫通線５ｄ，５ｅが挿通されていずれも信号現示切替え制御器６に接続されている。

【００１８】図３において、灯器Ｌ１が点灯しているときには、電流センサ１ａが「オン」、灯器Ｌ２が点灯しているときには、電流センサ１ａと、電流センサ１ｂとが「オン」、灯器Ｌ３が点灯しているときには、電流センサ１ｂが「オン」、灯器Ｌ３が点灯しているときには、電流センサ１ｂが「オン」、灯器Ｌ４が点灯してい

るときには、電流センサＣＴ１が「オン」、灯器Ｌ４が点灯しているときには、電流センサ１ｂと、電流センサ１ｃとが「オン」、灯器Ｌ３が点灯しているときには、電流センサ１ｂが「オン」となり、各電流センサに得ら＊＊れた検出出力は、故障検知部３に入力される。以上の結果をまとめると表１の通りである。

【００１９】

【表１】

各電流センサの電流あり、なし			点灯消灯の判定結果
A	B	C	
○	×	×	Ｌ１点灯
×	○	×	Ｌ３点灯
×	×	○	Ｌ５点灯
○	○	×	Ｌ２点灯
×	○	○	Ｌ４点灯
×	×	×	Ｌ１～L5 全て消灯

【００２０】電圧監視装置２は、信号機への送出端電圧を検知するものであり、信号現示切替え制御器６とともに信号ケーブルの信号灯トランス７の出力側配線に並列に接続され、その検出出力は、いずれも故障検知部３に入力される。故障検知部３はＣＰＵであり、図４に示すようにメモリ部８と処理部９とを有し、その入力部３ａには、各電流センサ１ａ，１ｂ，１ｃと電圧監視装置２とのアナログ信号が入力され、入力部３ａにて変換されたデジタル信号が処理部９にて信号処理される。

【００２１】メモリ部８は、初期設定により設定された設定情報を記憶し、その設定情報を処理部９に出力するものである。処理部９は、時間処理部１０と、断線検知部１１と、短絡検知部１２と、現示判断部１３とからなり、メモリ部８から入力された設定情報をもとに、信号機稼動時の断線故障限界値と、稼動部時の短絡故障限界値とを割り出してそれぞれの故障限界値を断線検知部１１と短絡検知部１２とに出力するものである。時間処理部１０は、電流センサ１ａ，１ｂ，１ｃからの入力と、電圧監視装置２からの入力との時間同期処理を行うものであり、同期監視情報を断線検知部１１と、短絡検知部１２とに出力する。

【００２２】断線検知部１１は、電流センサ１ａ，１ｂ，１ｃから出力される信号機の消費電流と、電圧監視装置２から出力される送出端電圧とを同期監視し、その同期監視情報をコンピュータ処理して信号機側到達電圧（着電圧）を計算し、断線故障電流値（断線故障限界値）を割り出して信号灯のＬＥＤの全断故障、半断故障、正常の判定を行う。

【００２３】断線検知部１１が行う全断異常判定機能、半断異常判定機能及び正常判定機能は、以下の通りである。すなわち、全断異常判定機能は、メモリ部８に記憶されている設定情報をもとに計算した信号機稼動状態における全断故障限界値と、同期監視情報から演算された信号機稼動状態における測定値とを比較し、信号機稼動状態における全断故障限界値よりも信号機稼動状態における測定値が低下しているときは全ての信号灯のＬＥＤが断線故障している全断状態であると判断する機能である。

【００２４】半断異常判定機能は、メモリ部８に記憶されている設定情報をもとに計算した信号機稼動状態における半断故障限界値と、同期監視情報から演算された信号機稼動状態における測定値とを比較し、信号機稼動状態における半断故障限界値よりも信号機稼動状態における測定値が低下しているときは信号灯の一部のＬＥＤが断線故障している半断状態であると判断する機能である。

【００２５】正常表示機能は、同期監視情報から演算された信号機稼動状態における測定値が、信号機稼動状態における半断故障限界値と、信号機稼動状態における短絡故障限界値との範囲内のときにはいずれの信号灯のＬＥＤも断線、短絡故障していない断線、短絡なしの現示正常であると判断する機能である。

【００２６】短絡検知部１２は、電流センサ１ａ，１ｂ，１ｃから出力される信号機の消費電流と、電圧監視装置２から出力される送出端電圧とを同期監視し、その同期監視情報をコンピュータ処理して信号機側到達電圧（着電圧）を計算し、短絡故障電流値（故障限界値）を割り出してＬＥＤの短絡か、どうかの判定を行う。

【００２７】短絡検知部１２が行う短絡異常判定機能は、メモリ部８に記憶されている設定情報をもとに計算した信号機稼動状態における短絡故障限界値と、同期監視情報から演算された信号機稼動状態における測定値とを比較し、信号機稼動状態における短絡故障限界値よりも信号機稼動状態における測定値が上回っているときは多数の信号灯のＬＥＤが短絡している短絡状態であると判断する機能である。

【００２８】断線検知部１１と、短絡検知部１２との判定結果は、現示判断部１３に出力され、現示判断部１３

は、時間処理部を経由して得られた測定値情報から、現示の特定を行うとともに、断線検知部１１と短絡検知部１２との判定結果を表示部１４に表示し、また、必要のときには警報を出力する。

【００２９】図５に故障検知部３が実行する故障検知処理のフローを示す。図５において、各電流センサー１ａ，１ｂ，１ｃに得られた電流測定入力と、電圧監視装置２に得られた電圧測定入力とをそれぞれ入力部に入力し（ステップ１）、ついで、処理部９の時間処理部１０において、両入力を時間同期処理する（ステップ２）。処理部９においては、ついで、電流センサ１ａ，１ｂ，１ｃから出力される信号機の消費電力と、電圧監視装置２から出力される送出端電圧とを同期監視し、同期監視情報を得る（ステップ３）。

【００３０】この同期監視処理情報に基づいて現示判定処理を行う（ステップ４）が、この現示判定処理に際しては、メモリ部８への初期設定情報を入力し、同期監視情報から信号機側到達電圧（着電圧）を計算し（ステップ５）、断線故障電流値（故障限界値）及び短絡故障電流値（故障限界値）を割り出し(ステップ６)、メモリ部８に記憶されている初期設定情報を基に計算した信号機稼動状態における全断故障限界値、半断故障限界値または短絡故障限界値と、同期監視情報から演算された信号機稼動状態における測定値とを比較し、全断、半断あるいは短絡の異常判定を行い（ステップ７）、異常の継続時間が、予め定められた時間を超えたときには、警報が出力され（ステップ８）、表示部１４は、発生した異常の内容を表示する。

【００３１】もっとも、ステップ７で異常の判定がなされなかったとき、あるいは異常が生じても、その異常の継続時間が予め定められた時間を超えなかったときには、正常の表示がなされる（ステップ９）。図６にステップ８における全断異常、半断異常及び短絡異常の判定基準となる各故障領域の電圧と、電流との関係の一例を示したものである。

【００３２】図６において、横軸は（送電圧ー着電圧）、縦軸は（動作電流／全点灯電流）×１００に選び、横軸目盛りが０すなわち、着電圧が送電圧に等しいときに、全点灯電流に対する動作電流の比が１２５％を下限として、それ以上を短絡故障領域、５０％を上限として、それ以下を全断領域、５０％を下限、７５％を上限とし、５０％～７５％の範囲を半断故障領域に設定している。この結果、７５％以上、１２５％以下が正常動作領域となる。もっとも、着電圧が増大するにしたがって、半断故障の上限値並びに全断故障の上限値が上昇してゆく。

【００３３】本発明においては、３個の電流センサの内の一個又は２個の電流センサに流れる電流の有無を検知して５灯の信号灯器の点灯、消灯を判別し、さらに、各電流センサから出力される信号機の消費電流と、電圧監視装置から出力される信号機への送出端電圧とを同期監視をして、信号現示の正常、異常を判断し、信号灯器に使用されたＬＥＤに全断異常、半断異常あるいは短絡異常が発生したときには、警報を出力し、あわせて発生した異常の内容が表示される。

【００３４】本発明を適用する多灯形色灯信号機は、５現示の信号灯の例に限られるものではないが、４現示以下の信号機においても、断線検知には最小限３個の電流センサが必要になることから、本発明においては、特に５現示の信号機に用いて好適である。もっとも、本発明の故障検知装置は、信号現示の数より少ない数の電流センサを用いた故障検知装置に適応する場合に限らず、多灯形色灯信号機のＬＥＤの故障検知に電流センサを用いる一般の故障検知装置にもまったく同様に適用することができる。

【００３５】

【発明の効果】以上のように、本発明によるときには、多灯形色灯信号機の発光源に用いられたＬＥＤの消費電流と、信号灯への送出端電圧とを同期監視し、その同期監視情報から信号機側到達電圧（着電圧）を計算し、全断、半断、短絡故障電流値（故障限界値）を割り出し、信号機稼動時の測定結果を、その故障限界値と、比較して信号灯の全断異常、半断異常並びに短絡異常を判定するものであるため、全断異常、短絡異常はもとより、電球フィラメント溶断時のような電流落差が無くても、故障限界値を設定してその設定値を越える部分断線を正確に監視できる。

【００３６】また、本発明によるときには、電源と、信号機間の配線ケーブルの長さの長短や電源の品質、電源電圧の低下といった信号機の設置現場の条件に左右されずにＬＥＤの点灯異常を正しく判断することができる。さらに本発明によれば、特定された灯器の点灯電流をより正確に計測することでＬＥＤの断線の程度を判定することも可能である。

【図面の簡単な説明】

【図１】本発明の一実施形態を示す故障検知回路の構成図である。

【図２】信号灯のＬＥＤの回路図である。

【図３】各灯器の点灯、消灯検知回路の概略図である。

【図４】故障検知部の構成図である。

【図５】故障検知処理のフロー図である。

【図６】断線、短絡故障の判定領域を示す図である。

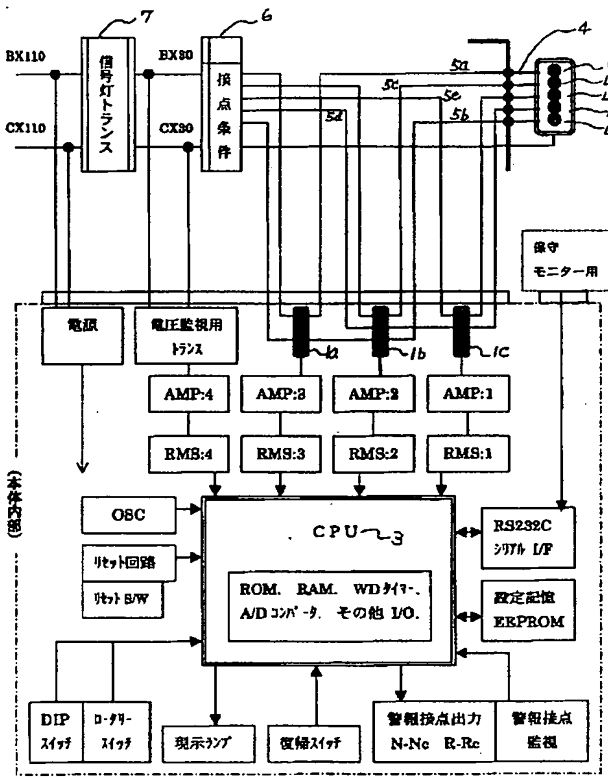
【符号の説明】

１ａ～１ｃ　電流センサ
２　電圧監視装置
３　故障検知部
４　信号ケーブル
５（５ａ～５ｅ）　電流測定用貫通線
６　制御器
６　信号現示切替え制御器

７　信号灯トランス
８　メモリ部
９　処理部
１０　時間処理部

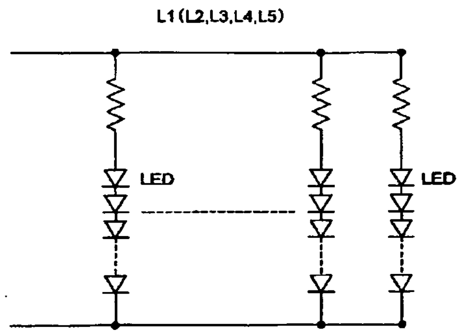
１１　断線検知部
１２　短絡検知部
１３　現示判断部
１４　表示部

【図１】

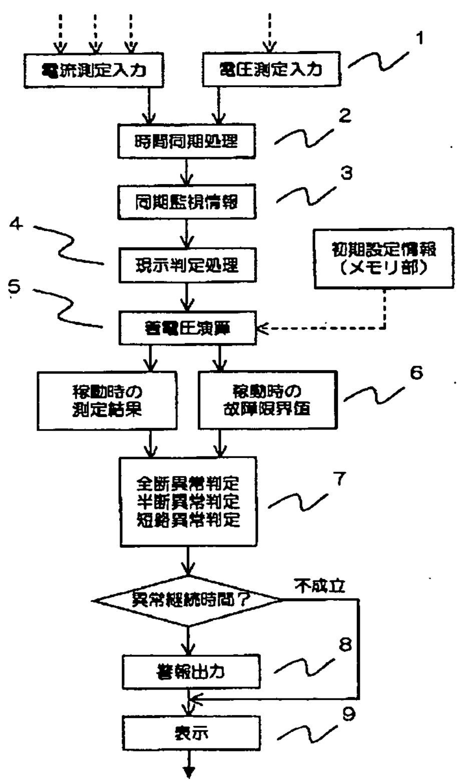


ＬＥＤ信号機用新断線検知器 内部構成図

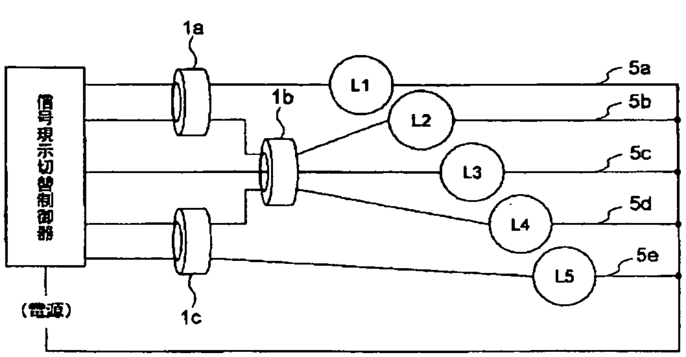
【図２】



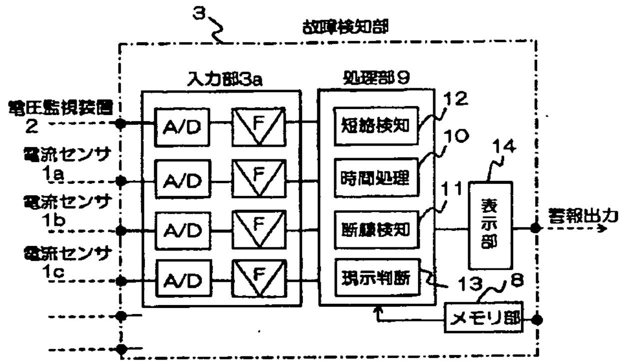
【図５】



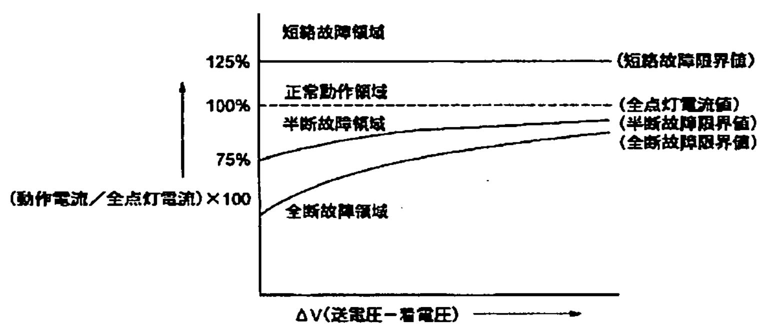
【図３】



【図４】



【図６】



各故障領域と電圧電流の関係